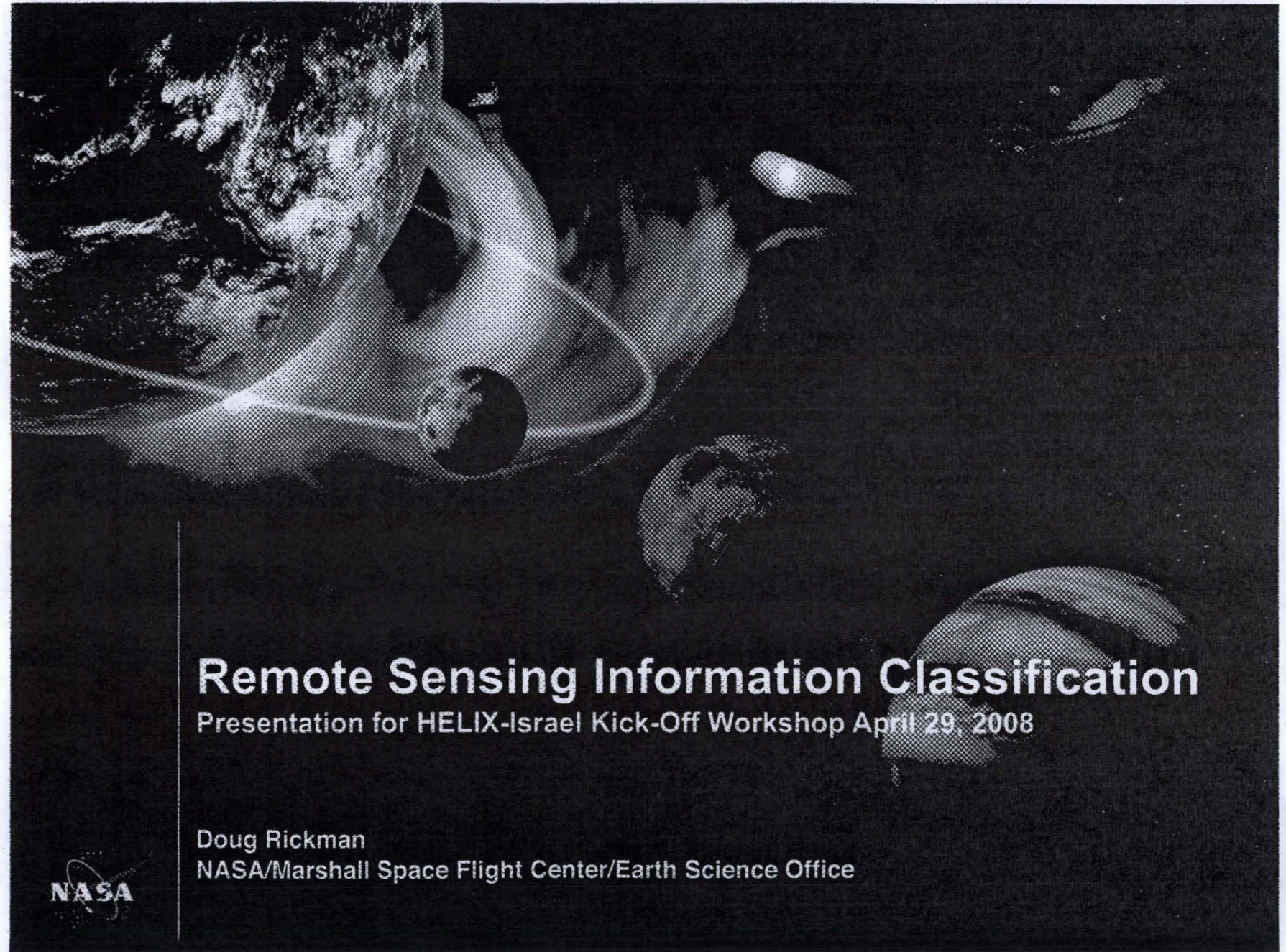


MSFC-767



Remote Sensing Information Classification

Presentation for HELIX-Israel Kick-Off Workshop April 29, 2008

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The remote sensing data offers a uniform measurement over a large area.

Remote sensing provides direct measurement of various geophysical properties, such as reflectance, emission and absorption of electro magnetic energy.

These geophysical properties are ***partially*** controlled by things of interest to epidemiologists, such as vegetation.

The actual remote sensing data can be used directly or

- It can be classified.
- It can be integrated into models.
- It can be converted into products.



Dimensionality

The sensor measures multiple wavelengths at each pixel.

All energy within a pixel for a wavelength band pass is integrated to a single integer in the range 0 – 255 (2^8).

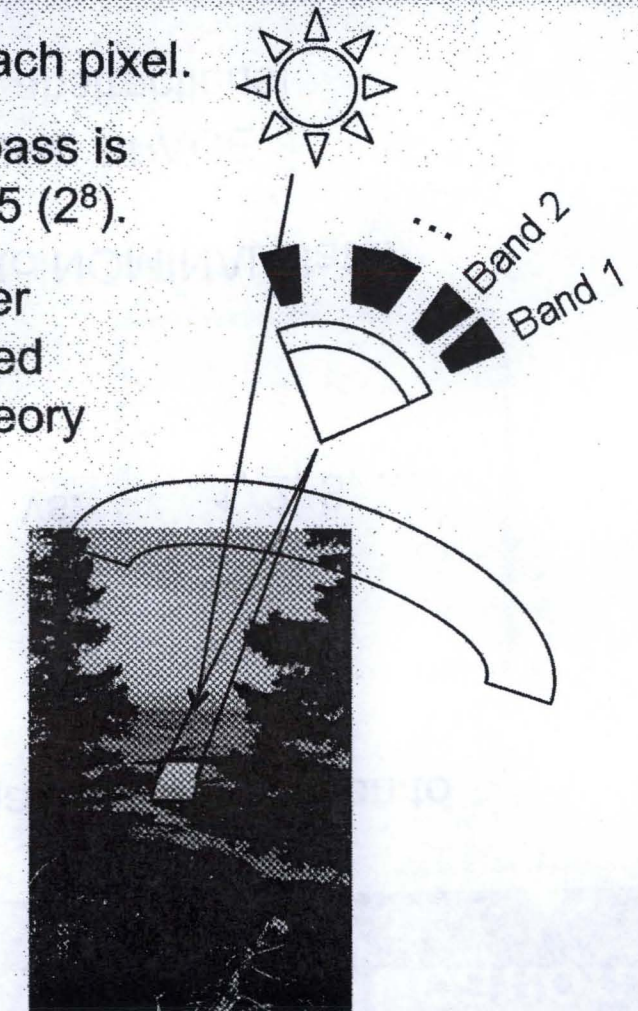
Each band is independent. The Thematic Mapper (TM) has 7 bands. For the TM a pixel is measured in 7 dimensions with a precision of 2^8 bits. In theory each pixel could have any one of $(2^8)^{**7}$ values.

This is a very, very big number.

In practice the bands are correlated and all the available dynamic range is not used. Practically, each pixel has only one of $\sim(2^7)^{**4}$ possible values.

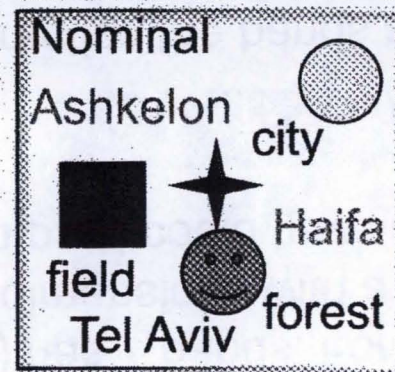


This is merely a very big number.

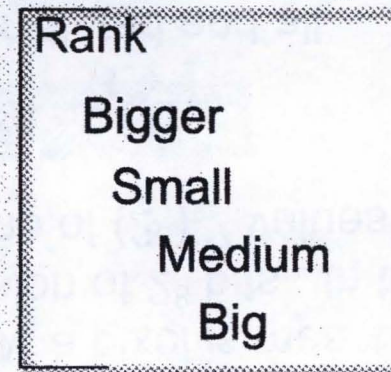


The Concept of Classification

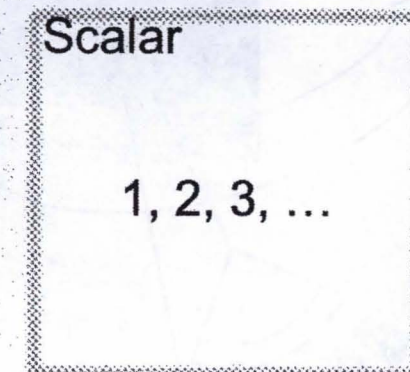
Classification is a way to reduce the dimensionality and precision to something a human can understand.



vs.



vs.



Classification changes SCALAR data into NOMINAL data!

The names used come from a FEATURE SPACE.
The names and the feature space are abstractions!

**Conversion from scalar to nominal loses
information and introduces error**

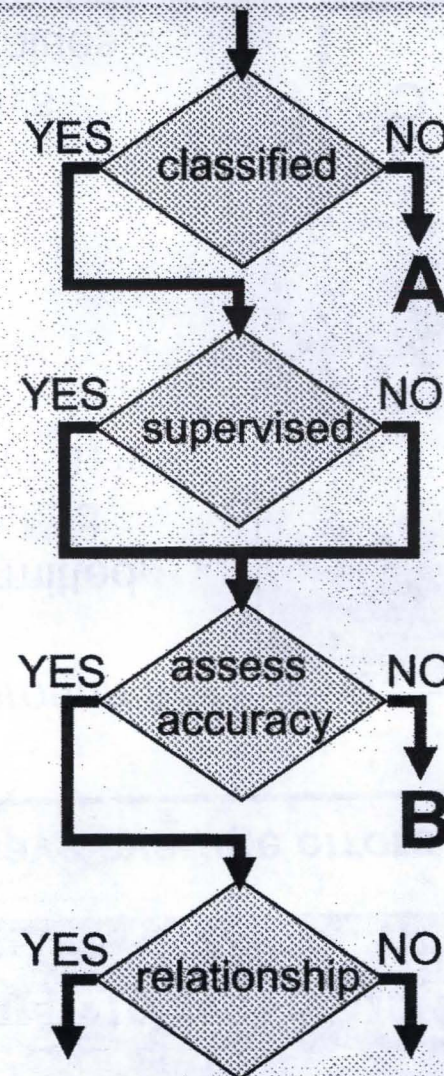


Process Logic

Start with the scalar
geophysical measurement

Classification creates a
statistical connection
between scalar data
and a feature space

How strong is the relationship
between the nominal
designation (the class) and
some "objective" standard?



Classification is **NOT**
required

The
"I hope I am right"
option

Sources of Classification Error

Most classifications have average errors in the range of 25 – 40%.

Example:

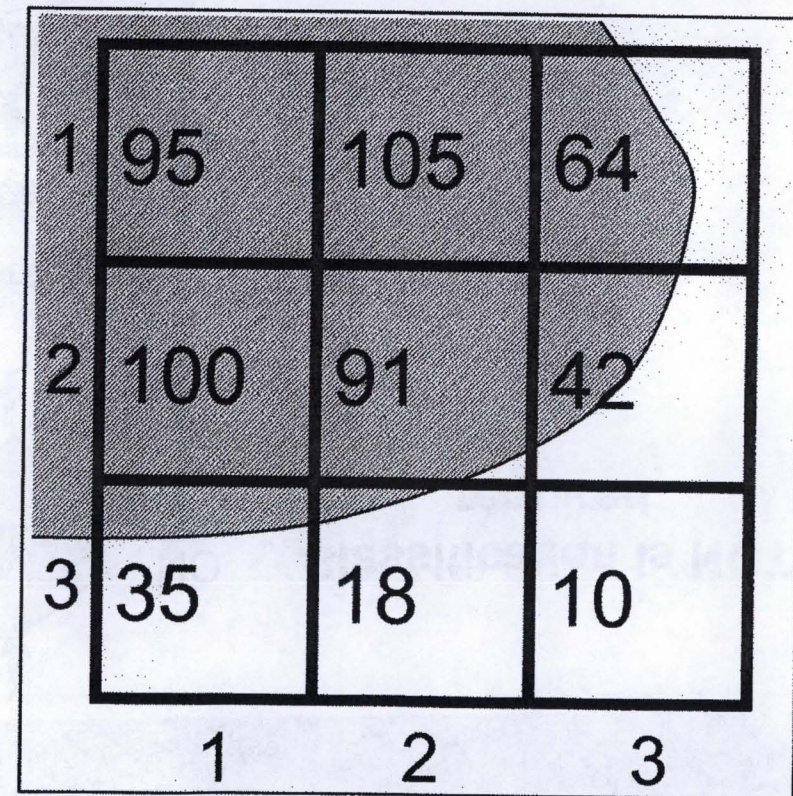
"Forcing a square peg through a round hole."

Only two classes are permitted, plain (low number) or hashed (high number). So pixel (2,3) is what?

Example:

"Variables don't and constants aren't."

The measurements always have "noise". Note the values in pixels (1,1), (1,2) and (2,1).



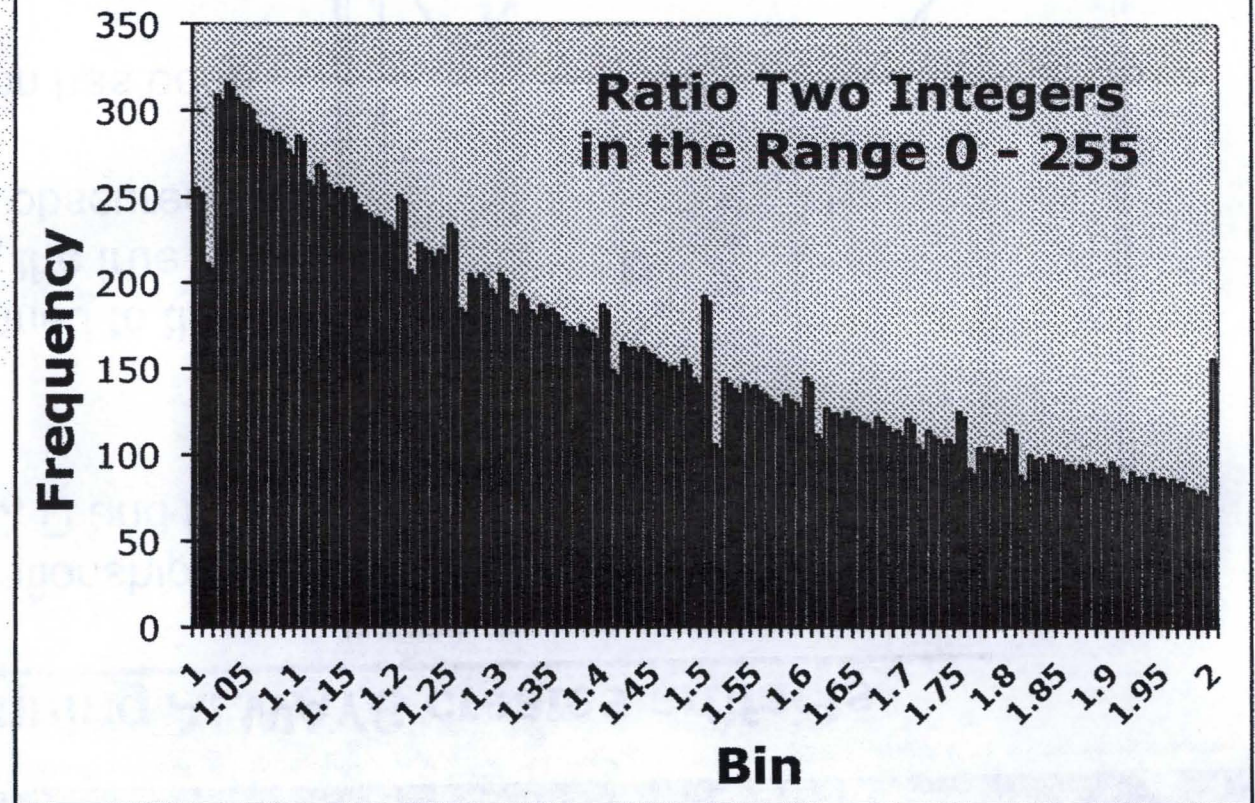
Algorithmic Logic Error

Example:

The raw satellite data are
INTEGER.

Most logical
algorithms
assume REAL
domain input.

This can cause
some fascinating
and entertaining
problems.



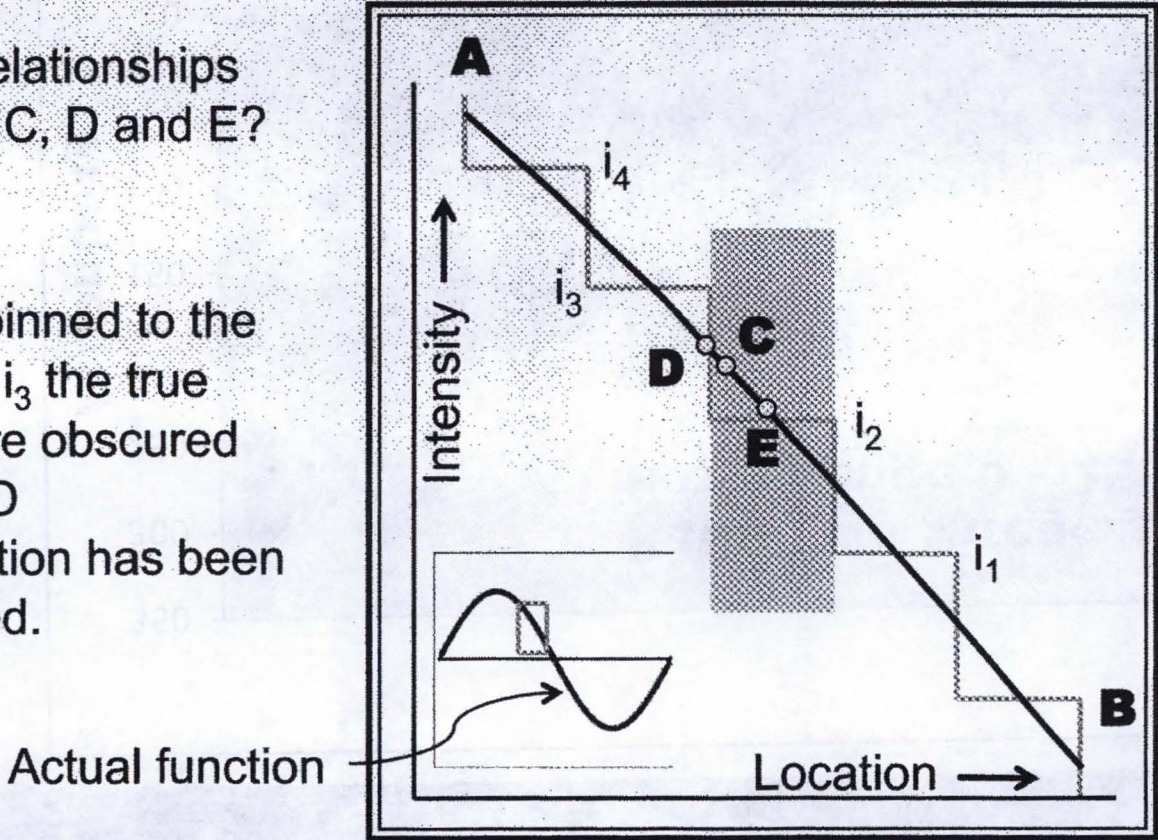


Mathematical Logic Errors

Binning ALWAYS creates artifacts

What are the relationships between points C, D and E?

If the data are binned to the values i_2 and i_3 the true relationship are obscured
AND





Conclusion & Recommendation

In a review of publications applying remote sensing to epidemiology

- most were found to use classification
- none gave any information about the accuracy of the classification.

Therefore, their results

- can only reveal how their health data related to their subset,
- they don't really know what that subset is,
- nor do they know if the subset can be reproduced!

It is strongly recommended that epidemiological studies utilize the full information content of the remote sensing material.

- This means using the full dimensionality or some statistically defensible expression of the total or a derived product.
- The computational burden, which 25 years ago was huge, is now easily handled by ordinary desktop systems.



Contacts & Acknowledgement

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http://weather.msfc.nasa.gov/helix/helix_home1.html

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